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# INTELLIGENT COMPUTER- AIDED TRAINING

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## **Intelligent Computer-Aided Training**

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## **Intelligent Computer-Aided Training**

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## Introduction

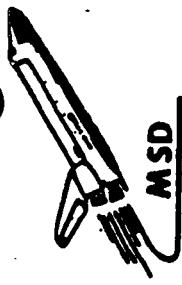
### Background

- Extensive research in the application of Artificial Intelligence technology to the tutoring task has been performed during the last fifteen years.
- No consensus on the detailed design of an architecture for these systems has emerged from this body of research.
- Significant evidence exists to support the efficacy of intelligent tutoring/training systems.
- The Space Station Freedom Program will require the development and maintenance of large number of training systems.
- Intelligent Computer-Aided Training (ICAT) systems offer the ability to deliver individualized training to large numbers of personnel in a workstation environment.

## Introduction

### Objectives

- A general architecture for ICAT systems for a wide range of NASA training tasks.
- A suite of software tools to facilitate the development of specific ICAT applications based on the general architecture.



## Introduction

### Approach

- The general ICAT architecture is being extended and refined through its use in building ICAT systems for use at JSC, KSC, MSFC, and GSFC.
- Existing software tools for use in the ICAT development environment are being evaluated.
- Based on these evaluations and ICAT application development experience, tool requirements are being developed.
- Software tools will be developed and integrated into a comprehensive workstation-based development environment.
- Individual elements of the development environment will be tested in on-going ICAT application projects.
- The integrated development environment will be tested at selected field sites.



## Results

### ICAT Architecture

The general ICAT architecture consists of

- Four cooperating expert systems
- Three systems are generic and are applicable to any procedural task
- The knowledge base related to the task to be trained is built on generic rule templates
- Communication via a common blackboard
- A graphical user interface that duplicates essential components of the task environment and provides an intuitive means for trainee interaction with the system
- An object-oriented database that contains the elements required for training scenario generation
- A dynamic data structure for modeling the trainee's current performance level and past history of system use
- System adaptability to individual trainees' backgrounds and learning rates
- Performance report generation for the trainee and trainer
- Capability of integrating speech recognition and speech generation



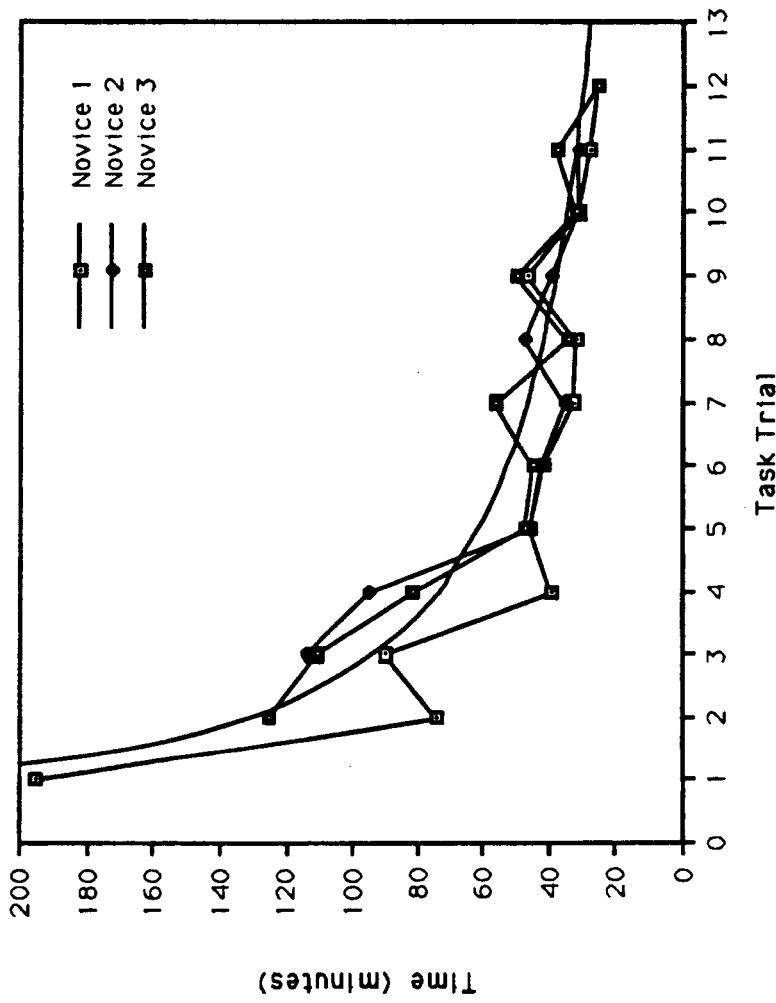
## **Results**

### **ICAT Applications and Projects**

- Payload-Assist Module Deploys/ICAT (PD/ICAT) has been operational and has been used by both novice and experienced Flight Dynamics Officers.
- Vacuum-Vent-Line/ICAT (VVL/ICAT) has been developed and delivered on a PC.
- Main Propulsion Pneumatics/ICAT (MPP/ICAT) is under development for use by test engineers at KSC.
- Instrument Pointing System/ICAT (IPS/ICAT) is under development for Payload and Mission Specialists at MSFC and JSC
- GSFC has initiated the development of an ICAT system for satellite controllers based on the general ICAT architecture.
- SBIR Phase I and II for integration of ICAT technology with existing simulators
- SBIR Phase I for passive knowledge acquisition
- CLIPS Intelligent Tutor
- Propulsion Console Trainer (Air Force)
- Technology Utilization Projects



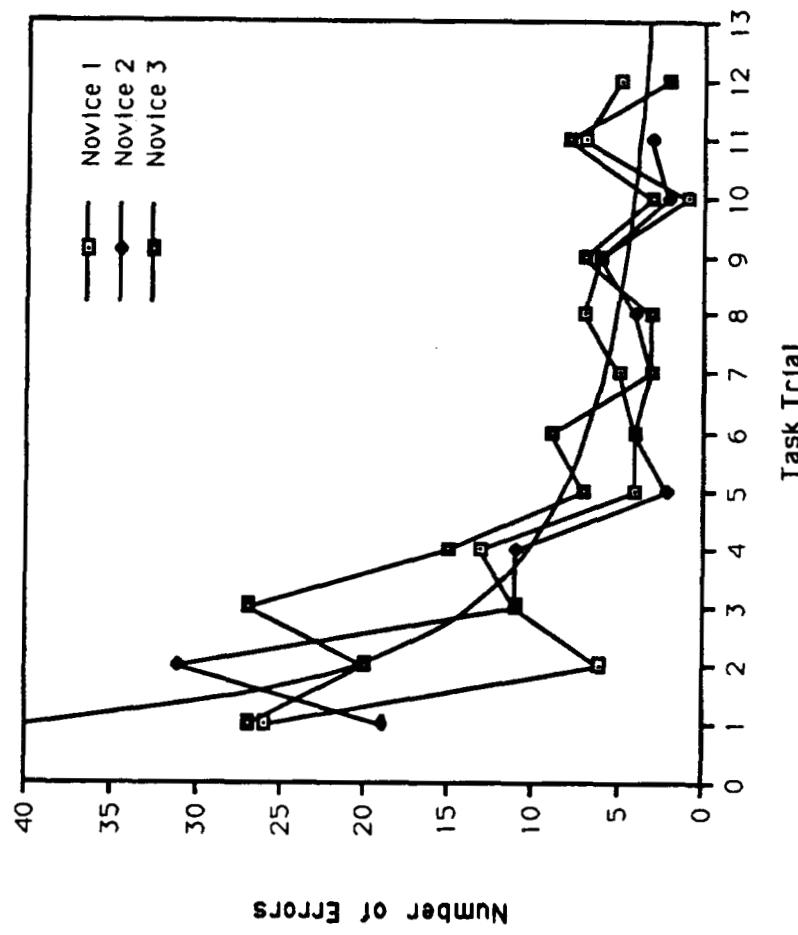
## Results



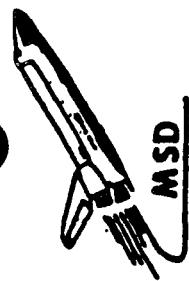
PERFORMANCE DATA FOR PD/ICAT: TASK COMPLETION TIME



## Results



PERFORMANCE DATA FOR PD/ICAT: TRAINEE ERRORS



## **Results**

### Knowledge Acquisition Tools

- Twenty-one knowledge acquisition tools have been evaluated.
- Evaluation reports have been widely shared with other NASA centers and key external researchers.
- Two types of knowledge acquisition tools will be required for ICAT development:
  - A tool for capturing knowledge of how to perform a time/event-driven procedural task.
  - A tool for capturing knowledge of the elements required to build training scenarios and trainers' expertise in evaluating trainee performance.
- Detailed requirements for these tools are nearing completion.



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**Results**

User Interface Development

- Extensive investigation of interface development alternatives has led to the selections of X-Windows as the medium of choice.
- Essential common elements of ICAT interfaces have been developed in X-Windows and demonstrated on the Sun, Apollo, Masscomp, and PC. Examples include:
  - Formatted data displays
  - Hierarchical menus
  - Keypads
  - Digitized images
- Development of requirements for a high-level tool for the production of ICAT interface components in X-Windows is underway.

**Results**

**Additional Requirements**

Additional requirements are under development for the following software tools:

- Knowledge Base Editor  
An editor is required to aid in adapting the generic rule-bases of the ICAT architecture for specific training applications.
- Object-Oriented Database Editor  
A tool is needed to facilitate the input of scenario definition data into the object-oriented database that creates training scenarios.
- Speech Recognition/Generation  
Tools are required to build the grammars needed by the Speech Systems, Inc. speech recognition system and to assist the linkage of speech recognition/generation to the basic ICAT elements.

**Transition**

- Demonstrations of ICAT applications for Space Shuttle tasks are underway.
- Cooperation with training organizations with Space Station responsibilities will continue.

**Issues**

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**Issues and Problems:**

- Integration of ICAT systems with existing and future simulation-based training systems
- On-board Training
  - Long-duration missions
  - Complex tasks infrequently performed
  - Astronaut perceptions
  - Hardware requirements



## **Conclusions**

- A robust and general ICAT architecture is in place and undergoing testing and refinement through application development.
- The efficacy of ICAT systems has been demonstrated through the use of the PD/ICAT system.
- Significant progress has been made in identifying the requirements for tools required to aid in the rapid development of specific ICAT applications based on the general ICAT architecture.